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NOTE

Absorption Properties of Pr^{3+}-doped Fluoroborate and Boro-Tellurite Glasses

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This paper reports the preparation and spectral analysis of two series of Pr^{3+}-doped glasses of the compositions:
Fluoroborate glasses: B_2O_3–Na_2O–RF (= LiF and NaF)
Borotellurite glasses: B_2O_3–BaO–TeO_2–RF (= Li, NaF and KF)
The computed parametrization of both the physical and the non-linear spectra demonstrates the effects of alkali cations (Li, Na and K) in the glasses studied.

Earlier, we have reported the spectra of Nd^{3+} doped fluoroborate and boro--tellurite glasses to verify the alkali content effects as the network modifiers[1, 2]. We now report the production and spectral analysis of the same series of glasses this time with Pr^{3+} ions as the dopants.

The two series of glasses in the following chemical compositions have been prepared by empolying the quenching technique[3–5]

Fluoroborate glasses:

Glass A: $81B_2O_3 + 10Na_2O + 8LiF + 1PrF_3$
Glass B: $81B_2O_3 + 10Na_2O + 8NaF + 1PrF_3$

Boro-tellurite glasses:

Glass A: $65B_2O_3 + 2TeO_2 + 12BaO + 20LiF + 1PrF_3$
Glass B: $65B_2O_3 + 2TeO_2 + 12BaO + 20NaF + 1PrF_3$
Glass C: $65B_2O_3 + 2TeO_2 + 12BaO + 20KF + 1PrF_3$

The prepared glasses are good in transparency and in green colour due to the homogeneous distribution of Pr^{3+} ions in these glasses. The glass densities and refractive indices at three different wavelengths (n_f, n_d and n_c) have been computed and from these quantities other related physical and non-linearity parameters have been evaluated by using the relevant expressions given in literature[6, 7]. Absorption spectra of these glasses have been recorded (420–620 nm) on a Perkin-Elmer 551 Spectrophotometer.

Particularly the glass-A from these two series of glasses have shown significant variations in physical and non-linearity parameters compared to other glasses. Absorption spectra of Pr^{3+}-glasses have shown four absorption bands $^3H_4 \rightarrow {}^2P_{2,1,0}$ and $^1D_2$. Energy level structure parametrization has been carried out[8]. By employing the literature methods[9, 10] Judd-Ofelt intensity (Ω_λ)

TABLE-1

OPTICAL DENCITY (OD IN ARBITRARY UNITS), OSCILLATOR STRENGTH ($f_{ed} \times 10^6$), JUDD-OFELT INTENSITY ($\Omega_\lambda \times 10^{20}$ cm^2) AND ENERGY LEVEL STRUCTURE PARAMETERS OF Pr^{3+}-DOPED GLASSES

Absorption bands	Fluoroborate glasses				Boro-tellurite glasses					
	Glass-A		Glass-B		Glass-A		Glass-B		Glass-C	
	OD	f_{ed}	OD	f_{ed}	OD	f_{ed}	OD	f_{ed}	OD	f_{ed}
$^3H_4 \rightarrow {}^1D_2$	0.78	13.17	0.57	0.95	0.09	0.64	0.07	0.63	0.08	0.61
$\rightarrow {}^3P_0$	1.77	11.33	1.56	1.06	0.30	0.97	0.34	0.96	0.32	0.92
$\rightarrow {}^3P_1$	2.01	11.50	1.77	1.07	0.32	0.99	0.32	0.97	0.30	0.93
$\rightarrow {}^3P_2$	2.85	25.41	2.85	2.53	0.51	1.80	0.51	1.76	0.47	1.69
Ω_2	806.74		297.10		16.27		16.09		15.38	
Ω_4	20.03		18.86		1.70		1.68		1.60	
Ω_6	47.42		46.87		3.19		3.15		3.02	
Energy level parameters										
E^1 (cm^{-1})	4942		5866		5730		6295		6783	
Recah E^2 (cm^{-1})	23		16		16		13		9	
E^3 (cm^{-1})	475		474		468		474		471	
Spin-orbit ξ_{4f} (cm^{-1})	738		763		835		794		827	

parameters of these glasses have been computed Table-1 and these intensity parameters are in the following manner.

$$\Omega_2 > \Omega_6 > \Omega_4$$

Among the measured absorption bands, $^3H_4 \rightarrow {}^3P_2$ has been the hypersensitive transition. The following Table-2 shows the relationship between the values of Ω_2 and the hypersensitive transition spectral intensity (f_{ed}) in both the series of glasses

TABLE -2

Parameters	Fluoroborate glasses		Boro-tellurite glasses		
	Glass-A	Glass-B	Glass-A	Glass-B	Glass-C
Ω_2 (10^{20} cm^2)	806.74	297.10	16.27	16.09	15.38
f_{ed} ($^3H_4 \rightarrow {}^3P_2$)	25.41	2.53	1.80	1.76	1.69

From these data it is noted that, among the Pr^{3+} glasses, glass-A in both the series with LiF content, is showing better spectral intensities. The radiative properties of the excited states are also found to be satisfactory in glass-A compared to the other glasses studied.

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